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CORALS THAT LIVE ON MOUNTAINTOPS

BY FAN TSAO AND LANCE E. MORGAN

IN RECENT YEARS, *scientists, with backing from the National Oceanic and Atmospheric Administration's (NOAA's) Office of Ocean Exploration (OE) program, have begun to investigate underwater mountains called seamounts. A variety of diverse deep-sea corals have been discovered living at great depths. Despite this wave of exploration, only a small fraction of seamounts have been visited by scientists, though it is likely that most shallow seamounts (those with summits less than 1,000 m below the ocean surface) have already been commercially fished.*

Numerous extinct and active volcanoes stand thousands of meters tall on the seafloor in U.S. waters. From New England to Alaska, scientists dive beneath the sea to explore seamounts, often finding diverse communities of deep-sea corals growing on the summits and slopes of these undersea mountains. Living with these deep-sea corals are fishes and invertebrates deriving benefits from the corals' three-dimensional structures.

A seamount is defined as an underwater mountain rising more than 1,000 m above the surrounding seafloor. Deep-sea corals live on seamounts because underwater currents flow faster above seamounts, sweeping away sediment and revealing rocky outcrops for the corals to settle and grow on (Stone et al., 2004), and delivering food particles for deep-sea corals to eat. Because rocky seafloor is rare and productivity is limited in the deep sea, seamounts are an ideal place for filter-feeding animals like deep-sea corals to live (Genin et al., 1986). The distribution of deep-sea corals on seamounts also suggests the importance of water currents. Deep-sea corals tend to concentrate on the tops of sharply peaked seamounts as opposed to the slopes, but on seamounts with flat tops, corals reside along the perimeter of the flat top–in both cases, where currents are the strongest (Genin et al., 1986; De Vogeleare et al., 2005). Currents may carry more coral larvae to seamounts allowing greater colonization of seamounts than of the surrounding seafloor (Genin et al., 1986). In addition, under certain environmental conditions, currents above seamounts can develop into a gyre, or circular eddy, that traps larvae and prevents them from drifting away from the seamount.

Because of these unique characteristics and the rarity of seamounts in the deep sea, many have very high levels of endemism (species unique to one area of the world). In one study of seamounts located in the Tasman and Coral Seas, researchers found 850 new species (Richer de Forges et al., 2000): 42 percent more than were discovered in the past 125 years of seamount research combined. Moreover, 34 percent of these species were potential endemics. Another study determined that 16 to 33 percent of the 300 fish and invertebrate species found on seamounts south of Tasmania were restricted to seamount environments (Koslow et al., 2000). Commercially valuable fishes aggregate around seamounts (e.g., orange roughy [*Hoplostethus atlanticus*] and pelagic armorhead [*Pseudopentaceros wheeleri*]), but their low productivities and long life histories make them incredibly vulnerable to overfishing, and the type of fishing gear used–bottom trawls–results in damage to delicate structures such as deep-sea corals (Morato et al., 2004; Koslow et al., 2001). Many other species, including pelagic fishes, seabirds, and marine mammals, often concentrate above seamounts.

Below we highlight some of the recent explorations of seamounts off the east and west coasts of the U.S. and in the Gulf of Alaska and Hawaii that have yielded exciting discoveries of deep-sea coral communities and a better understanding of the close relationship between corals and seamounts.

NEW ENGLAND SEAMOUNT CHAIN

The 1,500 km long New England Seamount Chain consists of extinct volcanoes stretching form offshore Cape Cod to halfway across the western Atlantic. The bases of these seamounts are 5,000 m deep, but their tops reach depths of 1,500 m. Recent research cruises revealed an astonishing diversity of life on these unique seamount habitats and a high abundance of deep-sea corals. In 2003, researchers onboard the deep-diving submersible *Alvin* photographed and collected seamount fauna on Bear, Kelvin, and Manning Seamounts. In 2004, scientists used remotely operated vehicles (ROVs) equipped with robotic claws to survey the same seamounts in addition to Balanus and Retriever Seamounts. The ROVs took thousands of high-resolution digital images (Figure 1), and the claws collected boxes of selected specimens. They also brought to the surface some fossil corals for climate researchers to study. Scientists reported 24 coral species between the depths of 2,200 and 1,100 m, including ubiquitous bubblegum

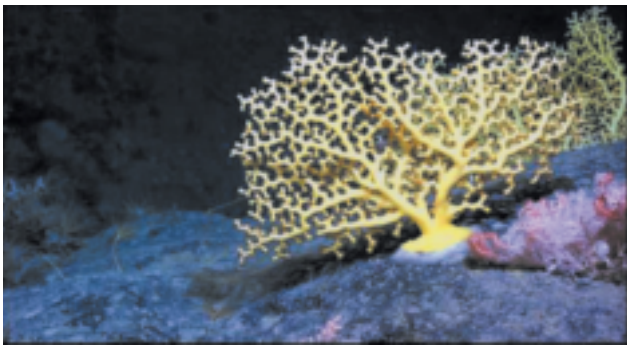

Figure 1. This stunning yellow *Enallopsammia* stony coral with pink *Candidella* is teeming with brittle stars on Manning Seamount. Image taken by researchers on the NOAA "Mountains in the Sea 2004" cruise.

corals (*Paragorgia* spp.) and two-meter tall whip corals (*Lepidisis* spp.). Balanus Seamount, explored in 2004, has a forest of whip corals reaching heights of four meters. Fish eggs, from a not yet identified species, were attached to *Metallorgorgia* branches, indicating that deep-sea corals may be important nursery grounds for fish. Marine biologists also found bioluminescent bamboo corals (*Keratoisis* spp.) that emitted blue-green light when disturbed.

DAVIDSON SEAMOUNT

Davidson Seamount is a massive seamount 120 km southwest of Monterey, California. Its large base occupies a 40 km by 10 km area at a depth of 3,650 m. The 2,400 m tall seamount is marked by dense ridges. In 2002, scientists conducted 90 hours of surveys on the seamount over the course of six ROV dives. Deep-sea corals were distributed from almost 3,000 m deep to the seamount top. Deep-sea coral forests were concentrated on the high-relief ridges near the top, where bubblegum corals grow to two meters tall and two meters wide. This cruise also observed soft mushroom corals (*Anthomastus* spp.), black corals (*Antipatharia* spp.), and pink corals (*Corallium* spp.). Almost all of the corals had associated fauna, ranging from polycheate worms, basket stars, octopuses, to thornyhead fish (De Vogeleare et al., 2005).

GULF OF ALASKA SEAMOUNTS

The 2004 Gulf of Alaska research cruise visited five seamounts in the Kodiak-Bowie Seamount Chain with 18 submersible dives down to a depth of 2,700 m. Like other seamount cruises, this one revealed deep-sea coral species new to science. Scientists found high levels of deep-sea coral diversity as well as a high diversity of associated fishes and invertebrates. The most abundant corals are red-tree (Primnoids), bubblegum, bamboo (Isidids), and black corals. Beside collecting corals with the submersible's arms and visually documenting the coral habitats, scientists also used a slurp gun to vacuum animals from the corals and bring them to the surface in order to further analyze the composition of the deep-sea coral ecosystem. They found that crabs, brittle stars, and shrimps are common associates of the corals. Certain species are found only on corals and nowhere else on the seabed, such as the galatheid crab (*Gastroptychus iaspus*) and the unbranched basket star (*Asteronyx* spp.). Species assemblages in coral habitat vary with depth, but researchers suspect these species associate with corals for three reasons: 1) suspension feeders climb on corals to elevate themselves off the seafloor for faster current flow, which carries more food; 2) small crustaceans use coral structures as refuge from predators; and 3) some species such as sea stars and sea spiders feed on corals directly.

HAWAIIAN RIDGE - EMPEROR SEAMOUNTS

This chain of islands and seamounts extends some 6,000 km from a submerged active volcano just southwest of the island of Hawaii to the Aleutian Trench off Alaska. The Hawaiian islands themselves are not seamounts—yet. But as they subside into the north Pacific they will become seamounts in coming millennia. Scientists have explored small sections of this chain and found intriguing animals such as deep-sea corals, including valuable precious corals belonging to three families: gold coral (Parazoanthidae; Figure 2), red or pink coral (Corallidae), and bamboo coral (Isididae). Another taxon, black coral (Antipathidae), is collected at shallower depths and polished into jewelry. Perhaps the most significant fact about the Emperor Seamount chain is the history of exploitation of fishes in this region prior to scientific discovery. The pelagic armorhead fishery began in 1968 when Russian fishermen began fishing the summits and upper slopes of seamounts in the southern Emperor Seamounts. By 1975, the combined Russian and Japanese catch totaled approximately one million tons of fish. In 1978, the U.S. began regulating this fishery on the Hancock Seamounts, which are within the U.S. EEZ in the northernmost section of the Northwestern Hawaiian Islands. However, management was too late in coming, and in 1986, a fishing moratorium was put in place after the fishery collapsed. In 2004, even after an 18-year moratorium, fish populations show no evidence of recovering.

There are an estimated 15,000 to 100,000 seamounts in the world, yet only a small percentage have been explored. There is reason to believe that more wonders of the deep sea are waiting to be discovered, but these ecosystems are fragile and under growing threat from bottom-trawl fishing. Conservation organizations are currently advocating at the United Nations for a moratorium on high-seas bottom trawling to protect seamounts, but as yet there is little or no protection in international waters for these unique ecosystems and species. In the U.S., Davidson Seamount was set aside from trawling recently, and some protection from bottom fishing has been accorded the Gulf of Alaska Seamounts by the North Pacific Fishery Management Council. These are laudable steps to protect seamounts and to conserve the deep-sea corals and other species that inhabit these places.

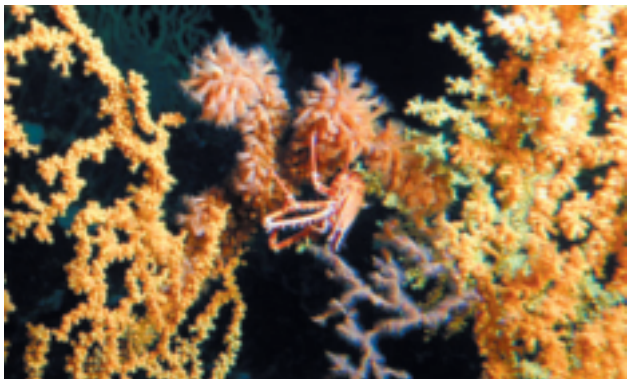

Figure 2. A large galathaeid crab on gold coral on Cross Seamount in Hawaii. Image taken by researchers on the NOAA "Deep-Sea Precious Corals" cruise in 2004.

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FOR MORE RESOURCES:

Seamounts Online:
http://seamounts.sdsc.edu/

Davidson Seamount:
http://oceanexplorer.noaa.gov/explorations/02davidson/davidson.html

Gulf of Alaska Seamounts:
http://oceanexplorer.noaa.gov/explorations/04alaska/welcome.html

New England Seamounts:
http://oceanexplorer.noaa.gov/explorations/04mountains/welcome.html

Northwestern Hawaiian Island Seamounts:
http://oceanexplorer.noaa.gov/explorations/02hawaii/welcome.html

PHOTO CREDITS:

Page 10: Courtesy of NOAA and Researchers on the "Mountains in the Sea 2004" Cruise

Page 11: Courtesy of Amy Baco-Taylor; Thomas Shirley; Pilots T. Kerby and M. Cremer; and NOAA

Did You Know?

During the first year of the orange roughy fishery on South Tasman Rise seamounts off Australia, an estimated 1.6 tons of coral were caught as bycatch by fisherman per hour of fishing, resulting in a total bycatch of 10,000 tons of coral that year.